

Report

monitoring of the Amudarya river delta and the exposed bed of the Aral Sea within the framework of the CAWA Project - Dynamics of surface water and groundwater changes in the Amudarya river delta and the exposed bed of the Aral Sea June 2009 - September 2011

According to the plan of monitoring (surface and ground water quantity and quality) in the Amudarya Delta and on the dried bed of the Aral Sea, data for analysis of processes taking place in this area were collected over July-September 2011.

In order to improve monitoring in the Amudarya delta and Prearalie, 21 new gauging stations were constructed under the CAWA project in early 2011. By present, these new gauging stations have been transferred to operating organizations. Now, water levels and discharge in canals, collector drains, and lakes in the Amudarya river delta are measured at these stations (Fig.1).

In early August 2011, SIC ICWC organized inspection of these structures. The group was composed of: O.Eshchanov, leading environmental expert of SIC, CAWA project executor; Sh.Tolepova, CAWA project specialist; representatives of Prearalie delta authority and Hydrogeological-land reclamation field office of Karakalpakstan; and, persons responsible for these sites.

During inspection of new gauging stations, the present status of Amudarya delta was studied as well. At the beginning of August 2011 it was recorded that actually river water did not reach the Samanbay and Kyzyljar sections of the Amudarya river and, respectively, the Mejdurechenskoye reservoir as well. Water accumulated in Mejdurechenskoye reservoir is used only for irrigation of crops. The inspection showed that river water does not flow from Marinkin canal to Rybachie bay, from Glavmyaso canal to Muinak bay, and from Kazakhdarya to Djyltyrbas lake. River water is not discharged from Roushan canal into Ustyurt collector drain as well.

It was identified from visual observations that Ustyurt and GLK collector drains did not transport water to Sudochie lake, as well as KC-1 and KC-3 collector drains did not bring water to Djyltyrbas lake. In early August, the Right-bank collector drain - Akchadarya - was the only source of collector-drainage water flowing towards the Aral Sea. According to data of the Hydrogeological-land reclamation field office of Karakalpakstan, the amount of discharge from Akchadarya collector drain (zero end) towards the Aral Sea was 13 m³/s.

The observations revealed process of drying due to undersupply of water in water bodies. There is level lowering in all water bodies of the Amudarya delta. In August 2010, water level was above the design value in all water bodies, except for Muinak bay, whereas in August 2011 water level lowered substantially, even below the design value in all water bodies. The water level was 3.0 m and higher in Mejdurechenskoye in the last year. As compared to the beginning of current year until August, water level lowering was within 0.40-0.70 m.

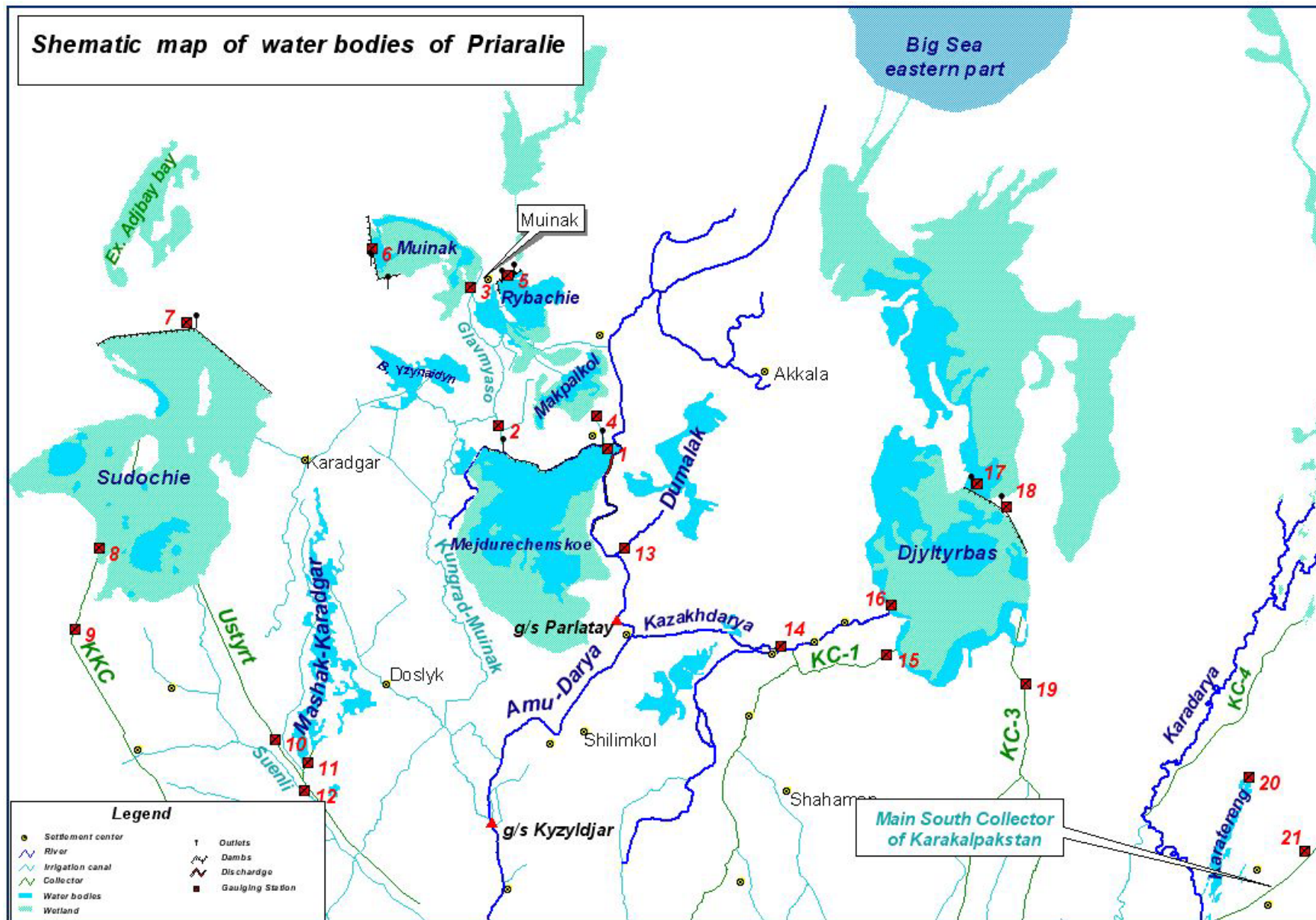


Fig. 1.



Fig. 2. South Prearalie and Large Aral Sea - August 2011

Based on satellite images, SIC ICWC determined water surface areas and wetland areas in South Prearalie as of September 2011 (Fig. 2, Tables 1, 2). Table 1 shows wetlands, for which water area was estimated on the basis of satellite images. For example, within the former Adjibay Bay, Adjibay 2 and others there is no currently an open water surface. This is related with relief of terrains, vegetative phase of plant communities, and inflow to South Prearalie.

Comparison of open water surface areas over April and September shows that slight decrease in water area took place in the following water bodies: Rybachie bay; Muinak reservoir; and, Makpalkol lake - within two thousand hectares.

More significant decrease in water areas is observed in:

- Mejdurechenskoye reservoir - by 9.1 thousand ha;
- Djyltyrbas (dammed) – by 8.8 thousand ha;
- Djyltyrbas wetland (together with former right and left channels) – 29.0 thousand ha;
- Mashan-Karadjar lake system – by 6.0 thousand ha;
- Water surface along the Kazakhdarya river channel – by 4.8 thousand ha.

The comparison of data from March (beginning of vegetative phenological phase of plant communities in South Prearalie) to September 2011 shows that the larger area of lake flood flow is typical for April, while the maximum area of wetlands in observed from August till September. The ratio of water surface and wetlands in South Prearalie is show in Figure 3.

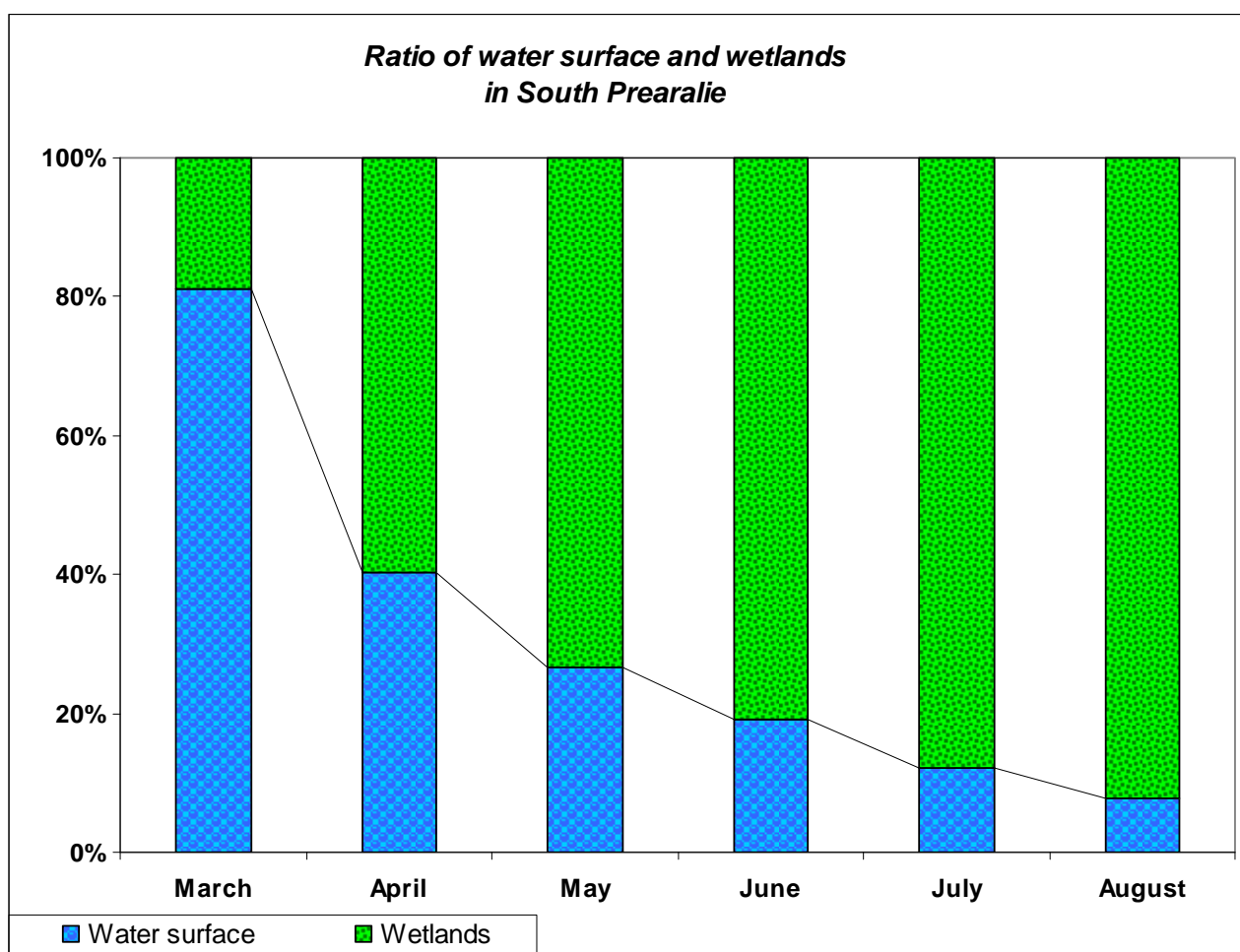


Fig. 3. Ratio of water surface and wetlands in South Prearalie

Water surface areas decreased practically by 86 thousand ha since April till September, whereas wetland areas increased by 139 thousand ha during the same period of time (the data are shown in Tables 1 and 2).

Water surface areas of the bays in Large Aral Sea and levels and volumes in Eastern and Western bodies of the Large Aral Sea were determined (Table 3).

As the data show, the catastrophic drying process is ongoing due to undersupply of water to the Large Aral Sea, especially its Eastern body. The water surface area of Eastern body was 4583.96 km² in March, whereas it decreased to 2267.65 km² in September.

Satellite images for July, August, and September 2011 were processed in order to assess dynamics of Eastern and Western bodies of the Large Aral Sea. Water levels in the sea and water volume in the Eastern body were defined more precisely (Table 4).

The data show (Table 4) that after decrease of inflow to the delta and the Aral Sea in 2011, water level in the Eastern body lowered by 0.8 m from 28.4 m to 27.6 m in September. Correspondingly, water volume decreased twice and finally was equal to 3.0 km³. As to the Western body, water level remained unchanged at 27.8 m, and water volume was 53.27 km³.

Table 5 gives data on changes in wetland areas in the Amudarya river delta over the last 10 years. Table 5a shows data received as a result of processing of NOAA images on areas of wetlands (lake systems, in hectares) over 2009-2011. The wetland area was about 105 thousand ha in November 2009, while it amounted to as much as 226 thousand ha in April 2010, i.e. the area increased more than twice. According to SIC's GIS data, the area of wetlands increased up to 356 thousand ha in October 2010 года. The table shows that due to reduced inflows to the Amudarya delta, in early 2011 in April-May the area of wetlands was 207 thousand ha but by September it increased to 292 thousand ha.

**Comparison of open water surface areas, ha
(November 2010 and March-September 2011)**

Table 1

| Water body | November 2010 | March 2011 | April 2011 | May 2011 | June 2011 | July 2011 | August 2011 | September 2011 |
|--|------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------------------|
| 1. Sudochie | 31228.13 | 37092.19 | 35913.96 | 33648.61 | 24485.28 | 11069.20 | 8320.55 | 6185.61 |
| 2. Mejdurechenskoye | 10306.83 | 9129.81 | 9639.56 | 6782.32 | 4432.05 | 1810.49 | 1021.71 | 501.69 |
| 3. Rybachie | 5552.20 | 3794.98 | 5952.92 | 5147.21 | 4849.01 | 4506.62 | 3898.91 | 3069.57 |
| 4. Muynak | 4059.85 | 5182.66 | 5184.01 | 4272.57 | 3509.57 | 1944.59 | 1853.53 | 1543.02 |
| 5. Djyltyrbas, dammed | 28222.64 | 13821.67 | 13976.22 | 10008.75 | 8317.50 | 6975.49 | 6079.45 | 5060.18 |
| 6. Djyltyrbas (together with former right and left channels) | 14040.61 | 34609.06 | 29308.85 | 14233.13 | 11588.28 | 7965.55 | 6774.74 | - |
| 7. Dumalak | 3773.57 | 1506.72 | 1579.32 | 578.25 | 1152.46 | 361.41 | - | - |
| 8. Makpalkol | 2060.68 | 811.85 | 2533.15 | 1723.48 | 1871.28 | 1679.98 | 1183.93 | 950.23 |
| 9. Mashan-Karadjar | 7566.20 | 5269.31 | 6244.58 | 4472.06 | 2725.90 | 1541.69 | 906.57 | 215.70 |
| 10. Water surface southward of Muynak | 3937.60 | 2065.57 | 1562.82 | 853.12 | - | - | - | - |
| 11. Water surface along the Kazakhdarya river channel | 616.17 | 2976.06 | 4885.01 | 3139.67 | 1720.04 | 1486.70 | 813.92 | - |
| 12. Zakirkol lake | 819.02 | 546.38 | 1010.07 | 353.99 | 357.78 | - | - | - |
| Total | 115183.5 | 102984.59 | 103814.3 | 75204.41 | 56691.65 | 39341.72 | 24773.85 | 17526.01 |

Comparison of wetland areas, ha (March-September 2011)

Table 2

| Water body | Wetlands March | Wetlands April | Wetlands May | Wetlands June | Wetlands July | Wetlands August | Wetlands September |
|--|---------------------------|---------------------------|-------------------------|--------------------------|--------------------------|----------------------------|-------------------------------|
| 1. Sudochie | - | 29707.42 | 31547.52 | 33782.09 | 43742.16 | 43212.64 | 38915.36 |
| 2. Mejdurechenskoye | - | 1845.53 | 19181.39 | 18061.27 | 23174.17 | 23940.74 | 22464.96 |
| 3. Rybachie | - | 2163.22 | 3931.89 | 4247.80 | 4529.71 | 4682.17 | 5531.11 |
| 4. Muynak | - | 7328.11 | 7830.41 | 9129.10 | 9793.37 | 10191.76 | 9832.71 |
| 5. Djyltyrbas, dammed | - | 18898.65 | 27340.65 | 33854.90 | 33797.10 | 32166.29 | 37543.86 |
| 6. Djyltyrbas (together with former right and left channels) | - | 46525.38 | 62930.40 | 84745.11 | 102958.17 | 105510.70 | 113097.43 |
| 7. Former Adjibai bay | 12299.19 | 18773.25 | 19852.74 | 20320.06 | 20716.32 | 20807.54 | 21023.07 |
| 8. Dumalak | 2673.17 | 3403.11 | 10456.37 | 11247.56 | 14812.37 | 15926.23 | 15986.01 |
| 9. Adjibai 2*) | - | 2954.82 | 10785.62 | 11020.14 | 9825.73 | 10269.62 | 10614.93 |
| 10. Makpalkol | 375.91 | 415.89 | 9357.21 | 7548.23 | 7829.15 | 6227.70 | 5947.13 |
| 11. Mashan-Karadjar | 1873.21 | 4838.41 | 8596.91 | 9753.42 | 12585.21 | 14141.98 | 14128.59 |
| 12. Water surface southward of Muynak | - | 6620.41 | 7216.25 | 7574.51 | 7783.69 | 8647.12 | 8917.52 |
| 13. Wetland north-westward of Muynak | 3284.16 | 3372.18 | 3723.05 | 4815.21 | 5407.45 | 6792.69 | 6107.01 |
| 14. Water surface along the Kazakhdarya river channel | 2784.36 | 5483.46 | 9634.70 | 14805.13 | 17289.13 | 18651.34 | 16508.04 |
| 15. Zakirkol lake | 734.35 | 1236.08 | 2177.82 | 2345.17 | 3134.87 | 3241.65 | 3721.54 |
| Total | 24024.35 | 153565.92 | 207222.28 | 239394.8 | 283581.5 | 292243.88 | 292795.4 |

Estimation of water surface area in the Eastern and Western bodies of Large Aral Sea, 2009-2011, km²

Table 3

| Water body | November 2009 | November 2010 | March 2011 | April 2011 | May 2011 | June 2011 | July 2011 | August 2011 | September 2011 |
|--------------------------------|----------------------|----------------------|-------------------|-------------------|-----------------|------------------|------------------|--------------------|-----------------------|
| Western body | 3789.92 | 3931.87 | 3934.15 | 3881.74 | 3922.68 | 3977.23 | 3943.58 | 3924.89 | 3938.02 |
| Eastern body | 796.99 | 5210.67 | 4583.96 | 4526.52 | 4476.27 | 3702.15 | 2858.43 | 2451.28 | 2267.65 |
| Bays of Eastern body (Tshebas) | - | - | 2086.51 | 1740.01 | 1188.11 | 986.60 | 631.01 | 576.10 | 511.43 |
| Large Aral Sea | | | 10604.62 | 10148.27 | 9587.06 | 8665.98 | 7433.02 | 6952.27 | 6717.1 |

Levels and volumes in Eastern and Western bodies of Large Aral Sea

Table 4

| Year | Month | Eastern body | | Western body | |
|-------------|--------------|------------------------|--------------------------------------|------------------------|--------------------------------------|
| | | Water level (m) | Water volume (km³) | Water level (m) | Water volume (km³) |
| 2009 | November | 26.3 | 0.655 | 27.5 | 52.12 |
| 2010 | November | 29.0 | 8.38 | 27.8 | 53.27 |
| 2011 | March | 28.4 | 5.95 | 27.8 | 53.27 |
| 2011 | April | 28.6 | 6.62 | 27.7 | 52.84 |
| 2011 | May | 28.5 | 6.21 | 27.8 | 53.27 |
| 2011 | June | 28.2 | 4.7 | 27.9 | 53.64 |
| 2011 | July | 27.8 | 3.52 | 27.8 | 53.27 |
| 2011 | August | 27.6 | 3.0 | 27.8 | 53.27 |
| 2011 | September | 27.6 | 3.0 | 27.8 | 53.27 |

Area of wetlands in the Amudarya river delta, ha

Table 5

| № | Water body | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|----|-------------------------------|----------------|-----------------|-----------------|-----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|
| 1 | Sudochie | 6497.20 | 54768.62 | 54141.42 | 49635.15 | 59302.73 | 53394.24 | 42915.45 | 15489.62 | 49372.04 | 38915.36 |
| 2 | Mejdurechenskoye | 18375.21 | 31563.56 | 30242.67 | 38101.75 | 5633.97 | 29650.00 | 20315.28 | 30603.80 | 33593.58 | 22464.96 |
| 3 | Rybachie | 5513.10 | 9581.76 | 10578.35 | 10045.81 | 6319.38 | 5193.04 | 4972.89 | 3837.25 | 5585.05 | 5531.11 |
| 4 | Maynak | 5163.20 | 9023.62 | 9929.20 | 9477.51 | 16567.90 | 8543.63 | 5146.06 | 5138.86 | 12049.45 | 9832.71 |
| 5 | Djyltyrbas* | 27620.50 | 94764.63 | 112217.30 | 136205.7 | 80993.93 | 97553.36 | 74816.57 | 39468.61 | 129967.97 | 113097.43 |
| 6 | Former Adjibai bay | 6784.70 | 19093.39 | 17329.11 | 21037.34 | 29676.83 | 27598.21 | 22214.60 | 3235.03 | 12824.64 | 21023.07 |
| 7 | Dumalak | 6784.90 | 29572.49 | 32557.36 | 32424.52 | 27119.00 | 13102.82 | 5169.07 | 8420.59 | 22809.08 | 15986.01 |
| 8 | Adjibai 2** | - | 4030.12 | 3978.29 | 3653.11 | 4848.33 | 2933.14 | 506.28 | - | 11738.26 | 10614.93 |
| 9 | Makpalkol | - | 5621.53 | 5931.62 | 6153.02 | 3590.45 | 10811.74 | 7946.95 | 9900.01 | 12599.68 | 5947.13 |
| 10 | Mashan-Karadjar | - | 13740.79 | 14769.00 | 10772.50 | - | 7570.02 | 3720.47 | 2243.49 | 4999.91 | 14128.59 |
| 11 | Muynak wetlands | - | 4048.18 | 4655.70 | 7460.03 | - | 5114.13 | 1606.41 | 1887.13 | 13058.62 | 15024.53 |
| 12 | Kazakhdarya wetlands | - | 8655.78 | 10564.11 | 18743.74 | - | 5024.46 | 1061.91 | - | 14618.34 | 16508.04 |
| 13 | Zakirkol lake | - | 2924.85 | 3085.05 | 3410.45 | - | 1927.25 | 2231.51 | 2516.35 | 2882.52 | 3721.54 |
| | Total area | 79552.7 | 287389.3 | 309979.2 | 347120.6 | 234052.5 | 267416.04 | 192623.5 | 122740.7 | 326099.1 | 292795.4 |
| | Water supply, Mm ³ | 112.00 | 117.00 | 37.00 | 1551.00 | 77.00 | 57.00 | 14.00 | 1050.00 | 3911.00 | |
| | | | | | | | | | | | |

*) Djyltyrbas - together with former right and left channels.

**) Adjibai 2 – artificial structure northward of Rybachie and Muynak reservoirs.

Wetland areas, ha
(Results of NOAA image processing)

Table 5a

| № | Water body | 2009 | | | 2010 | | | 2011 | | | | | |
|-----|---|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | | Sept | Oct | Nov | Apr | July | Oct | Apr | May | June | July | Aug | Sept |
| 1. | Sudochie | 12648 | 32733 | 31366 | 63364 | 50165 | 59729 | 29707 | 31548 | 33782 | 43742 | 43213 | 38915 |
| 2. | Mejdurechenskoye | 19908 | 14795 | 10678 | 19548 | 30789 | 27938 | 1846 | 19181 | 18061 | 23174 | 23941 | 22465 |
| 3. | Rybachie | 2066 | 15725 | 16841 | 9014 | 4719 | 4922 | 2163 | 3932 | 4248 | 4530 | 4682 | 5531 |
| 4. | Muynak | 2133 | 6606 | 5356 | 5126 | 10783 | 12555 | 7328 | 7830 | 9129 | 9793 | 10192 | 9833 |
| 5. | Djyltyrbas (dammed) | 27473 | 29615 | 30180 | 41060 | 44466 | 42349 | 18899 | 27341 | 33855 | 33797 | 32166 | 37544 |
| 6. | Djyltyrbas (right and left channels) | - | - | - | 89654 | 111294 | 142701 | 46525 | 62930 | 84745 | 102958 | 105510 | 113097 |
| 7. | Former Adjibai bay | - | - | - | 7563 | 9487 | 15429 | 18773 | 19853 | 20320 | 20716 | 20808 | 21023 |
| 8. | Dumalak | 2701 | 2747 | 2882 | 5069 | 16815 | 27620 | 3403 | 10456 | 11248 | 14812 | 15926 | 15986 |
| 9. | Adjibai 2* | | | | 6307 | 12751 | 19370 | 2955 | 10786 | 11020 | 9826 | 10270 | 10615 |
| 10. | Makpalkol | 7236 | 7710 | 4931 | 10328 | 11258 | 11305 | 416 | 9357 | 7548 | 7829 | 6228 | 5947 |
| 11. | Mashan Karadjar | 1005 | 3116 | 2630 | 6434 | 6890 | 8384 | 4838 | 8597 | 9753 | 12585 | 14142 | 14129 |
| 12. | Wetland southward of Muynak | - | - | - | 3990 | 7173 | 10180 | 6620 | 7216 | 7575 | 7784 | 8647 | 8918 |
| 13. | Wetlands north-westward of Muynak | | | | | 3525 | 4975 | 3372 | 3723 | 4815 | 5407 | 6793 | 6107 |
| 14. | Wetlands at the head of Kazakhdarya river | | | | | 6111 | 8462 | 5483 | 9635 | 14805 | 17289 | 18651 | 16508 |
| 15. | Zakirkol lake | | | | | 2689 | 2492 | 1236 | 2178 | 2345 | 3135 | 3242 | 3722 |
| | Total | 75171 | 113047 | 104863 | 226397 | 284447 | 356064 | 153566 | 207222 | 239395 | 283582 | 292244 | 292795 |

On the basis of the plan for July-September 2011, monitoring of the Amudarya river delta was conducted and showed the following results:

In the three points (sections) along the Amudarya river (Takhiatash, Samanbay, Kyzyljar), water discharge and salinity were measured every quarter. The results are given Table 6.

Table 6 shows actual inflow in hydraulic structures (Takhiatash, Samanbay, and Kyzyljar) in the Amudarya lower reaches during May-December 2009, January-December 2010, and January-September 2011. The analysis of actual data over nine months of 2011 shows that inflow to Takhiatash section of the Amudarya river drastically fell to 554.98 Mm³ due to shortage of water. As compared to 2010, the amount of water flown to Takhiatash section over this period of time in 2011 is only 3.4 % (in 2010 – 16279.11 Mm³). The same situation is observed for Samanbay and Kyzyljar sections. River water salinity in these three sections was less than 1.0 g/l (May-June from 0.70 g/l to 0.90 g/l) in the first half of 2010. In April-June 2011, actual river water salinity ranged from 1.0 g/l to 1.6 g/l, and since August, due to increased flow in the Amudarya river, water salinity has decreased to 0.70-0.90 g/l.

Water supply to the Left Bank system is made through the Suenly canal (feeds Tallyk canal, Ustyurt collector drain feeding the Sudochie canal), while the Right Bank receives water through the Kyzketken canal (feeds Kegeily and Kuanysh-jarma canals) from Takhiatash waterworks. Table 7 gives the total water diversions from Suenly and Kyzketken canals to Amudarya delta systems for hydrological years.

At the head of two canals - Marinkin and Muynak - water discharge and salinity were measured monthly. The monitoring results – water delivery along canals since July to September 2011 are given in Table 8. The table shows that due to shortage of water, the canals were dry in the last 6 months. Water into the delta lakes flows from Muynak canal (Glavmyaso - originates from Mejdurechie and water is supplied to Muynak bay), Marinkin canal (Porlitau from Mejdurechie through Makpalkul lake to Ribachie lake) and Raushan canal (originates in Amudarya river and Suenly canal and has tail escape to Ustyurt collector drain, through which water is transported to Sudochie lake).

Water into the delta flows from both the river and the collector drains, such as KC-1, KC-3, KC-4, Akchadarya (right-bank), KKC and Ustyurt, as well as from Ustyurt to Mashankul lake (the Raushan canal carries water to Sudoche lake through the Ustyurt collector). The system of right-bank collector drain originates in Beruny collector drain, followed by Main South Karakalpakstan collector (GUKK) and Akchadarya collector, and, through channels Toguzkaran Janadarya, collector water flows into the Eastern body of the Large Aral Sea.

Tables 9 and 9a give data on inflows to the delta from collector drains from July to December 2009, from January to December 2010, and in January-September 2011. The total amount of collector water over 9 months in 2011 is only 906.38 Mm³; for comparison, this is 46.5 % of the amount of collector water for the same period of time in 2010.

Figure 4 gives analysis of data on Akchadarya collector (right-bank collector). The total inflow to Prearalie over nine months in 2011 from the right-bank Akchadarya collector was 326.4 Mm³.

Tables 10 and 10a show actual data on salinity of collector-drainage water flowing through collectors to the Amudarya river delta. Salinity of collector water changed from 2.60 g/l to 4.67 g/l over July-September.

The actual inflow to the delta from all collectors since 2002 to 2010 is given in Table 11. The data show that inflow from collectors to the delta in 2010 was twice as much as in

high-water years 2005 and 2007. However, in 2011 inflow of collector-drainage water decreased significantly due to low-water level in the Amudarya river.

These changes in water levels in the lake systems of the Amudarya delta are shown in Tables 12 and 12a. Water levels lowered in all lakes in May-June and in July-August 2011. Because of increased inflow of the Amudarya river, water levels in the lakes started to increase slightly in September.

Tables 13 and 13a give actual data on discharge and salinity of water spills from the lake systems into the Aral Sea. Salinity of discharge water ranged from 2.70 g/l to 5.80 g/l. There were no spills from lakes in July-September.

Quarterly measurements of groundwater level and salinity were made in 44 points in the Delta. The monitoring results are given in Tables 14, 14a, 14b and 15, 15a, 15b and shown in Figures 5 and 6.

Figure 7 shows “Transformation dynamics of the Aral Sea”, which was prepared by SIC’s GIS experts on the basis of satellite images over 2009-2011.

Actual inflow into the Amudarya River Delta (Mm³)

Table 6

| Section line | Months and years | | | | | | | | | | | | |
|-------------------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------------|
| | 2009 | | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Total for 2009 |
| Takhiatash | - | - | - | - | 31.47 | 123.7 | 286.6 | 1037 | 438.05 | 362.88 | 243.65 | 251.6 | |
| Samanbay | - | - | - | - | 28.12 | 105.5 | 280.4 | 1005 | 430.79 | 354.07 | 236.4 | 247.5 | |
| Kyzyljar | - | - | - | - | 19.21 | 77.67 | 237.7 | 890 | 418.88 | 338.26 | 212.54 | 229.7 | |
| | 2010 | | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Total for 2010 |
| | Takhiatash | 479.8 | 63.67 | 192.54 | 558.6 | 2799.4 | 2233.4 | 3704.8 | 3961.4 | 2285.5 | 870.1 | 308.45 | 349.06 |
| Samanbay | 387.9 | 60.48 | 190.51 | 548.4 | 2925.5 | 1994.1 | 3794.7 | 3977.0 | 1481.1 | 1001.3 | 286.67 | 387.03 | 17034.69 |
| Kyzyljar | 334.5 | 56.16 | 109.04 | 405.54 | 2844.3 | 1542.2 | 3500.3 | 3596.0 | 1402.4 | 860.4 | 201.4 | 343.96 | 15196.2 |
| | 2011 | | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Total for 9 months |
| | Takhiatash | 107.14 | 113.0 | 79.0 | 38.88 | 40.18 | 42.34 | 45.45 | 50.11 | 38.88 | | | |
| Samanbay | 92.0 | 108.0 | 73.0 | 30.68 | 31.69 | 35.34 | 41.87 | 36.14 | 40.52 | | | | 489.24 |
| Kyzyljar | - | - | 39.92 | 27.28 | 19.62 | 19.55 | 25.34 | 24.15 | 24.28 | | | | 180.14 |

Total water diversion and spill from Suenly and Kyzketken canals by delta systems

Table 7

| Structure | Hydrological year | | | | | | | | |
|---|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 2002-2003 | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 | 2010-2011 |
| Suenly and Kyzketken | | | | | | | | | |
| Water volume (diversion), Mm ³ | 3628 | 3255 | 3552 | 3186 | 1440 | 3196 | 3206 | 5312.21 | 2816.69 |
| Water volume (spill), Mm ³ | 1403 | 1873 | 719 | 1414 | 1511 | 369 | 284 | 1790.3 | |

Water delivery by canal, July-December 2009 and January-September 2011

Table 8

| Canal | Months | | | | | | | | | | | |
|---------------------------|--------|-------|-------|-------|------|------|-------|--------|-------|-------|------|-------|
| | 2009 | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Marinkin, Mm ³ | - | - | - | - | - | - | 12.7 | 85 | 97.5 | - | - | - |
| Muynak, Mm ³ | - | - | - | - | - | - | - | 38.2 | 77.0 | 39.8 | 13.0 | 8.3 |
| Raushan, Mm ³ | - | - | - | - | - | - | 36.4 | 89.5 | 153.6 | 77.4 | 15.1 | 23.7 |
| | 2010 | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Marinkin, Mm ³ | - | - | - | 46.66 | - | - | - | 120.53 | 40.18 | - | - | - |
| Muynak, Mm ³ | 22.29 | 7.78 | 10.37 | 12.96 | 4.9 | 7.8 | 34.13 | 42.77 | - | 13.39 | 12.1 | 10.72 |
| Raushan, Mm ³ | 64.02 | 19.81 | 43.54 | 24.9 | 10.7 | 10.8 | 10.52 | 11.49 | 3.46 | 54.22 | 4.49 | - |
| | 2011 | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Marinkin, Mm ³ | - | - | - | - | - | - | - | - | - | | | |
| Muynak, Mm ³ | 10.72 | 6.92 | 13.39 | - | - | - | - | - | - | | | |
| Raushan, Mm ³ | 1.0 | - | 6.22 | - | - | - | - | - | - | | | |

Actual inflow into the Delta from collectors

Table 9

| Collector | Months | | | | | | | | | | | |
|--|------------------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------------------------------|
| | 2009 | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| KC-1 Mm ³ | | | | | | | 16.5 | 37.8 | 29.5 | 26.8 | 35.5 | 195.6 |
| KC-3 Mm ³ | | | | | | | 10.5 | 13.7 | 26.2 | 9.9 | 2.3 | 76.45 |
| KC-4 Mm ³ | | | | | | | 4.6 | 11.5 | 8.8 | 3.5 | 1.1 | 37.6 |
| Raushan Mm ³ (Ustyurt and KKC) | | | | | | | 26.7 | 52.8 | 52.7 | 35.0 | 14.8 | 23.7 |
| Ustyurt to Mashankul lake | | | | | | | - | 7.36 | 9.6 | 1.3 | - | 5.51 |
| Akchadarya (Right-bank) | | | | | | | 41.58 | 74.99 | 69.73 | 41.65 | 41.48 | 36.38 |
| Total: | | | | | | | 99.88 | 198.15 | 196.53 | 118.15 | 95.18 | 375.24 |
| | 2010 | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| KC-1 Mm ³ | 42.60 | 31.88 | 36.45 | 36.3 | 45.5 | 48.2 | 66.17 | 69.16 | 49.8 | 34.48 | 27.73 | 16.42 |
| KC-3 Mm ³ | 20.47 | 7.335 | 16.33 | 22.3 | 21.4 | 22.8 | 26.64 | 35.02 | 22.01 | 6.64 | 15.56 | 17.28 |
| KC-4 Mm ³ | 13.22 | 9.073 | 8.812 | 9.07 | 12.7 | 14.0 | 13.11 | 17.43 | 16.64 | 8.57 | 11.92 | 8.29 |
| Raushan Mm ³ (Ustyurt and KKC) | 63.96 | 19.2 | 43.57 | 24.9 | 33.7 | 88.0 | 97.67 | 100.99 | 72.12 | 24.07 | 26.17 | 52.02 |
| Ustyurt to Mashankul lake | 7.38 | - | 4.82 | 3.37 | 2.01 | 22.29 | 21.82 | 22.65 | 11.67 | 1.18 | - | 5.43 |
| Akchadarya (Right-bank) | 78.57 | 56.71 | 43.03 | 81.13 | 48.38 | 45.36 | 83.45 | 77.18 | 60.99 | 47.91 | 44.06 | 27.13 |
| Total: | 226.2 | 124.2 | 153.01 | 177.07 | 163.69 | 240.65 | 308.86 | 322.43 | 233.23 | 122.85 | 125.44 | 126.57 |
| | Total for 2010: | | | | | | | | | | | 2324.2 Mm³ |

Actual inflow into the Delta from collectors (Mm³)

Table 9 a

| Collector | 2011 | | | | | | | | | | | |
|--|--|---------------|---------------|---------------|---------------|--------------|--------------|--------------|--------------|---|----|-----|
| | Months | | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| KC-1 Mm ³ | 24.08 | 20.64 | 19.85 | 18.14 | 13.09 | 10.97 | 10.35 | 7.39 | 16.68 | | | |
| KC-3 Mm ³ | 15.13 | 7.06 | 13.83 | 16.33 | 12.08 | 9.94 | 5.62 | 3.84 | 3.28 | | | |
| KC-4 Mm ³ | 7.69 | 5.74 | 5.13 | 5.18 | 3.56 | 3.97 | 3.83 | 2.14 | 3.37 | | | |
| Raushan Mm ³ (Ustyurt and KKC) | 59.72 | 44.24 | 57.54 | 49.17 | 25.24 | 15.21 | 14.81 | 14.77 | 16.85 | | | |
| Ustyurt to Mashankul lake | 3.38 | 1.84 | 5.93 | 2.42 | - | - | - | - | - | | | |
| Akchadarya (Right-bank) | 36.09 | 27.16 | 44.5 | 53.31 | 48.44 | 29.55 | 33.81 | 29.3 | 24.19 | | | |
| Total: | 146.09 | 106.68 | 146.78 | 144.55 | 102.41 | 69.64 | 68.42 | 57.44 | 64.37 | | | |
| | Total for January-September 2011: 906.38 Mm³ | | | | | | | | | | | |

**Actual inflow of surface (river and collector) water resources
to Right-Bank Djyltyrbas system in Eastern Body of the Aral Sea**

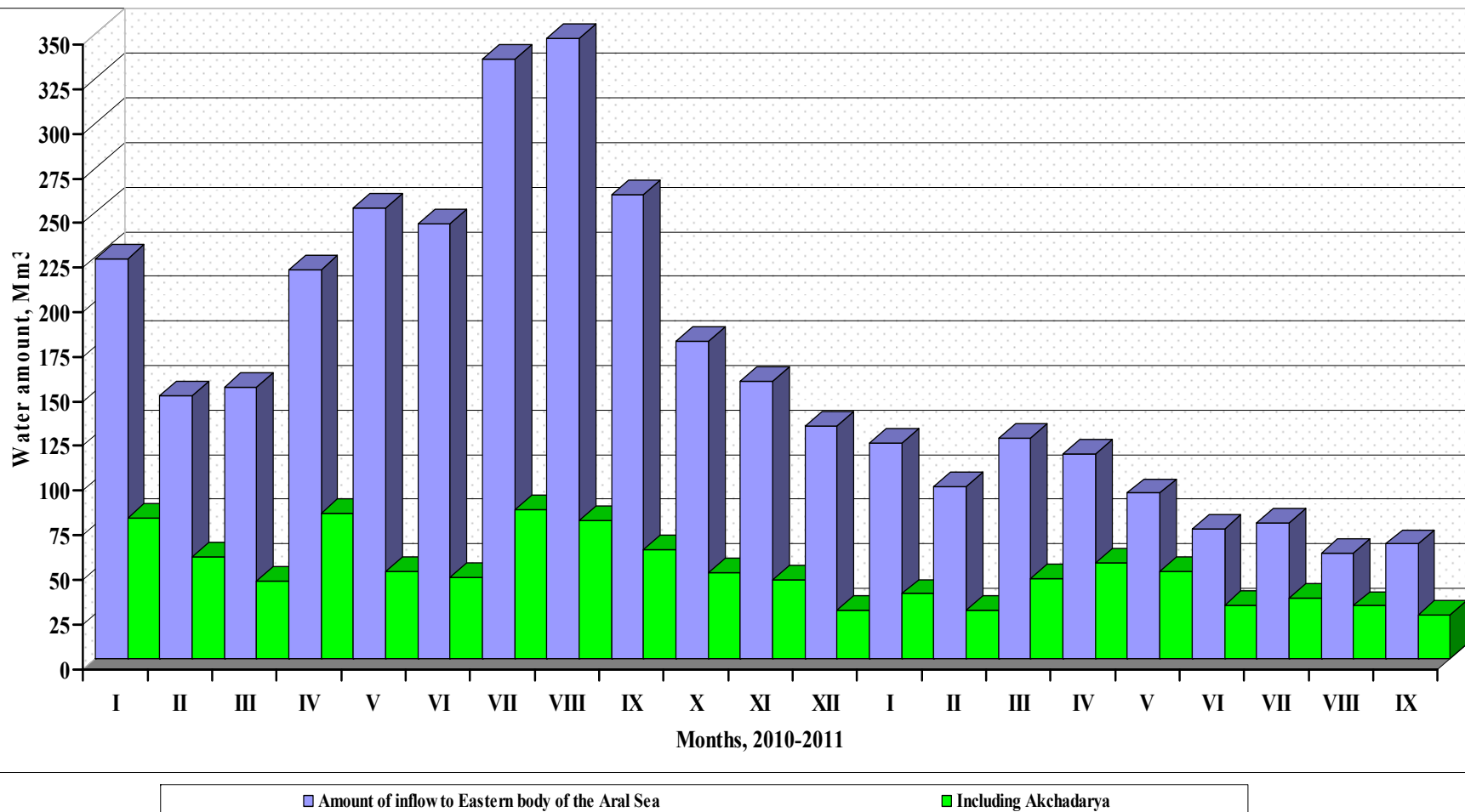


Fig. 4

Data on inflow from all collectors, 2002-2011

Table 11

| Collector | Year | | | | | | | | | |
|-------------------------------|------|------|------|------|------|------|-------|-------|--------|----------------|
| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011, 9 months |
| CDF (all collectors) | | | | | | | | | | |
| Water volume, Mm ³ | 437 | 1061 | 1083 | 1156 | 1432 | 1117 | 663.5 | 991.1 | 2324.2 | 906.38 |

Change in water horizon in the lake systems of the Amudarya Delta, January-December 2010

Table 12

| Lake | Sampling date | Water horizon | | | | | | | | | | | |
|------------------------------------|---------------|---------------|----------|--------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Sudochie 52.20 | 1 decade | 51.88 | 52.10 | 52.17 | 52.49 | 52.48 | 52.41 | 52.42 | 52.27 | 52.09 | 51.82 | 52.21 | 52.39 |
| | 2 decade | 51.98 | 52.14 | 52.18 | 52.49 | 52.48 | 52.41 | 52.42 | 52.27 | 52.09 | 52.00 | 52.29 | 52.43 |
| | 3 decade | 52.03 | 52.16 | 52.30 | 52.49 | 52.48 | 52.41 | 52.42 | 52.27 | 52.09 | 52.11 | 52.36 | 52.47 |
| Djyltyrbas 52.00 | 1 decade | 51.95 | 51.94 | 51.90 | 52.11 | 52.10 | | 52.14 | 52.35 | 52.37 | 52.35 | 52.27 | 52.27 |
| | 2 decade | 51.96 | 51.93 | 51.96 | 52.13 | 52.11 | 52.12 | 52.27 | 52.36 | 52.37 | 52.32 | 52.27 | 52.27 |
| | 3 decade | 51.96 | 51.92 | 52.06 | 52.13 | 52.12 | | 52.3 | 56.87 | 52.35 | 52.27 | 52.27 | 52.27 |
| Dautkul | 1 decade | 64.85 | 65.13 | 65.18 | 65.34 | 65.26 | | 65.37 | 65.37 | 65.34 | 65.36 | 65.34 | 65.28 |
| | 2 decade | 65.01 | 65.15 | 65.20 | 65.33 | 65.29 | 65.29 | 65.38 | 65.36 | 65.35 | 65.37 | 65.32 | 65.35 |
| | 3 decade | 65.10 | 65.17 | 65.29 | 65.35 | 65.32 | | 65.38 | 65.35 | 65.35 | 65.37 | 65.28 | 65.37 |
| Mejdurechie 56.00 | 1 decade | 55.69 | 56.01 | 56.03 | 52.82 | 56.17 | | 56.22 | 56.80 | 56.65 | 55.38 | 55.49 | 54.42 |
| | 2 decade | 55.75 | 56.02 | 55.99 | 55.74 | 56.78 | 56.63 | 56.72 | 56.71 | 55.81 | 55.32 | 54.70 | 54.96 |
| | 3 decade | 55.91 | 55.99 | 55.82 | 55.84 | 56.94 | | 56.95 | 56.86 | 55.58 | 55.49 | 54.79 | 54.82 |
| Rybachie 52.00 | 1 decade | 52.00 | 52.12 | 52.06 | 52.09 | 52.16 | | 52.29 | 52.12 | 52.40 | 52.30 | 52.24 | 52.24 |
| | 2 decade | 52.09 | 52.12 | 52.03 | 52.11 | 52.36 | 52.28 | 52.18 | 52.38 | 52.36 | 52.26 | 52.26 | 52.23 |
| | 3 decade | 52.11 | 52.09 | 52.05 | 52.06 | 52.33 | | 52.08 | 52.25 | 52.33 | 52.24 | 52.26 | 52.22 |
| Muynak bay 52.50 | 1 decade | 50.00 | 50.52 | 50.98 | 51.52 | 51.4 | | 51.35 | 51.40 | 51.46 | 51.48 | 51.57 | 51.67 |
| | 2 decade | 50.09 | 50.70 | 551.10 | 51.49 | 51.42 | 51.41 | 51.33 | 51.44 | 51.45 | 51.50 | 51.60 | 51.71 |
| | 3 decade | 50.30 | 50.86 | 51.33 | 51.52 | 51.39 | | 51.36 | 51.48 | 51.48 | 51.53 | 51.64 | 51.74 |
| Karateren | 1 decade | 47.41 | 47.56 | 47.72 | 48.9 | 49.00 | 48.7 | 48.53 | 48.61 | 49.08 | 48.99 | 48.82 | 48.88 |
| | 2 decade | 47.45 | 47.61 | 48.3 | 49.13 | 48.97 | 48.5 | 48.54 | 48.65 | 49.04 | 48.95 | 48.80 | 48.88 |
| | 3 decade | 47.52 | 47.68 | 48.65 | 49.10 | 48.78 | 48.56 | 48.58 | 48.78 | 48.99 | 48.95 | 48.80 | 48.90 |

Change in water horizon in the lake systems of the Amudarya Delta, January-September 2011

Table 12 - a

| Lake | Water horizon by month (m) | | | | | | | | | | | |
|----------------------------|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|---|----|-----|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Sudochie (52.20) | 52.58 | 52.48 | 52.51 | 52.49 | 52.43 | 52.25 | 52.09 | 51.86 | 52.01 | | | |
| Djyltyrbas (52.00) | 52.21 | 51.94 | 51.98 | 52.06 | 52.08 | 52.00 | 51.95 | 51.73 | 51.95 | | | |
| Dautkul | 65.37 | 65.37 | 65.36 | 65.31 | 65.13 | 64.88 | 64.67 | 64.37 | 64.64 | | | |
| Mejdurechie (56.00) | 54.15 | 54.92 | 55.23 | 54.98 | 54.64 | 54.35 | 54.04 | 53.63 | 54.04 | | | |
| Rybachie (52.00) | 52.20 | 52.16 | 52.15 | 52.12 | 52.04 | 51.91 | 51.72 | 51.44 | 51.72 | | | |
| Muynak bay (52.50) | 51.79 | 51.81 | 51.84 | 51.84 | 51.78 | 51.66 | 51.44 | 51.20 | 51.44 | | | |
| Karateren | 48.88 | 48.65 | 48.78 | 48.79 | 48.72 | 48.53 | 48.55 | 48.29 | 48.04 | | | |

Actual data on spills from the lake systems (Amudarya delta) into the Aral Sea in 2011

Table 13

| Lake | Spills from the lake systems by month, Mm ³ | | | | | | | | | | | |
|--------------------|--|-------|-------|-------|------|------|------|-----|------|-----|-----|-----|
| | January | Febr | March | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Sudochie | 9.5 | 45.79 | 35.86 | 60.48 | 4.32 | - | - | - | - | | | |
| Djyltyrbas | 95.9 | 39.84 | 27.22 | 34.56 | 5.18 | 2.59 | - | - | - | | | |
| Dautkul | - | - | - | - | - | - | - | - | - | | | |
| Mejdurechie | - | - | - | - | - | - | - | - | - | | | |
| Rybachie | 5.36 | 4.84 | 5.36 | 5.18 | - | - | - | - | - | | | |
| Muynak bay | - | - | - | - | - | - | - | - | - | | | |
| Karateren | - | - | - | - | - | - | - | - | - | | | |

Actual data on salinity of water discharged from the lake systems (Amudarya delta) into the Aral Sea in 2011

Table 13a

| Lake | Salinity of water from lake systems, g/l | | | | | | | | | | | |
|-------------|--|------|-------|-------|------|------|------|------|------|-----|-----|-----|
| | January | Febr | March | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Sudochie | 2.04 | 1.98 | 2.97 | 5.78 | 3.71 | 5.24 | 4.75 | - | - | | | |
| Djyltyrbas | 1.79 | 3.13 | 2.97 | 2.67 | 3.25 | 4.30 | 2.16 | 2.46 | 2.57 | | | |
| Dautkul | 3.48 | 3.82 | 3.17 | 3.27 | 2.13 | 3.38 | - | - | 3.13 | | | |
| Mejdurechie | 2.31 | 2.91 | 2.71 | 3.96 | 2.73 | 4.78 | 2.82 | 3.9 | 3.0 | | | |
| Rybachie | - | - | - | - | - | - | - | - | - | | | |
| Muynak bay | - | - | - | - | - | - | - | - | - | | | |
| Karateren | 2.70 | 2.70 | 2.99 | 3.69 | 3.65 | 2.90 | 3.3 | 2.67 | 3.19 | | | |

Data of monitoring over groundwater level in Prearalie, June-December 2009

Table 14

| № | Entity | Monthly changes in groundwater level (June-December 2009) | | | | | | |
|---|-------------------|---|------|--------|-----------|---------|----------|----------|
| | | June | July | August | September | October | November | December |
| 1 | sh/f* Aral | 6,08 | 6,02 | 5,61 | 5,77 | 6,07 | 6,06 | 6,02 |
| 2 | sh/f* Muynak | 6,33 | 6,37 | 6,26 | 6,46 | 6,05 | 6,42 | 6,27 |
| 3 | sh/f* Kazakhdarya | 4,09 | 3,79 | 3,62 | 3,52 | 3,59 | 3,55 | 4,02 |
| 4 | sh/f* Raushan | 4,68 | 4,99 | 5,0 | 5,0 | 3,46 | 3,57 | 2,64 |

Note: * - sh/f stands for shirkat farm

Data of monitoring over groundwater level in Prearalie, January-December 2010

Table 14 - a

| № | Entity | Monthly changes in groundwater level (January-December 2010) | | | | | | | | | | | |
|---|---------------------|--|----------|-------|-------|------|------|------|--------|------|------|------|------|
| | | January | February | March | April | May | June | July | August | Sept | Oct | Nov | Dec |
| 1 | sh/f Aral | 6,01 | 6,0 | 6,0 | 5.78 | 5.78 | 5.81 | 5,82 | 5,76 | 5,84 | 6.23 | 6.18 | 6.15 |
| 2 | sh/f Muynak | 6,5 | 6,5 | 6,4 | 5.41 | 5.43 | 5.37 | 5,46 | 5,54 | 5,78 | 5.86 | 5.95 | 6.15 |
| 3 | sh/f Kazakhdarya | 3,6 | 3,63 | 3,65 | 3.37 | 3.01 | 3.04 | 2,99 | 2,78 | 2,41 | 2.60 | 2.44 | 2.50 |
| 4 | sh/f Raushan | 3,15 | 3,07 | 2,47 | 2.26 | 2.34 | 2.11 | 2,00 | 1,85 | 1,80 | 2.02 | 2.38 | 2.38 |

Data of monitoring over groundwater level in Prearalie, January-September 2011

Table 14 - b

| № | Entity | Monthly changes in groundwater level (January-September 2011) | | | | | | | | | | | |
|---|---------------------|---|----------|-------|-------|------|------|------|--------|------|-----|-----|-----|
| | | January | February | March | April | May | June | July | August | Sept | Oct | Nov | Dec |
| 1 | sh/f Aral | 6.20 | 7.09 | 5.98 | 6.11 | 5.81 | 5.87 | 6.88 | 6.88 | 6.88 | | | |
| 2 | sh/f Muynak | 6.08 | 5.60 | 5.98 | 5.97 | 5.77 | 5.49 | 5.24 | 5.58 | 6.34 | | | |
| 3 | sh/f Kazakhdarya | 2.54 | 2.55 | 2.57 | 2.86 | 2.87 | 2.97 | 3.26 | 3.39 | 3.34 | | | |
| 4 | sh/f Raushan | 2.18 | 2.21 | 2.29 | 2.45 | 2.65 | 2.73 | 4.26 | 4.12 | 4.06 | | | |

Data of monitoring over groundwater salinity in Prearalie over 2009-2011 (g/l)

Table 15

| № | Entity | Monthly changes in groundwater salinity (June-December 2009) | | | | | | |
|---|------------------|--|------|--------|-----------|---------|----------|----------|
| | | June | July | August | September | October | November | December |
| 1 | sh/f Aral | 3.55 | 4.19 | 3.13 | 3.07 | 3.57 | 4.81 | 4.7 |
| 2 | sh/f Muynak | 5.74 | 6.59 | 5.11 | 9.4 | 11.04 | 7.62 | 7.0 |
| 3 | sh/f Kazakhdarya | 4.32 | 5.11 | 3.59 | 10.91 | - | - | 12.31 |
| 4 | sh/f Raushan | 4.81 | 4.3 | 4.69 | 2.4 | - | 6.08 | 4.74 |

Table 15 - a

| № | Entity | Monthly changes in groundwater salinity (January-December 2010) | | | | | | | | | | | |
|---|------------------|---|----------|-------|-------|------|------|------|--------|------|------|------|------|
| | | January | February | March | April | May | June | July | August | Sept | Oct | Nov | Dec |
| 1 | sh/f Aral | 5.27 | 4.84 | 3.8 | 3.1 | 2.69 | 2.5 | 3.28 | 2.72 | 3.15 | 3.53 | 3.86 | 4.18 |
| 2 | sh/f Muynak | 8.26 | 8.36 | 7.26 | 6.81 | 6.48 | 6.14 | 6.86 | 5.84 | 7.03 | 6.34 | 6.8 | 7.7 |
| 3 | sh/f Kazakhdarya | 13.95 | 13.88 | 12.76 | 8.54 | 8.59 | 8.21 | 6.55 | 6.41 | 7.65 | 7.02 | 7.4 | 8.44 |
| 4 | sh/f Raushan | 7.16 | 8.4 | 7.41 | 3.81 | 2.83 | 1.97 | 2 | 3 | 4.24 | 3.75 | 3.88 | 4.5 |

Table 15 - b

| № | Entity | Monthly changes in groundwater salinity (January-September 2011) | | | | | | | | | | | |
|---|------------------|--|----------|-------|-------|------|------|------|--------|------|-----|-----|-----|
| | | January | February | March | April | May | June | July | August | Sept | Oct | Nov | Dec |
| 1 | sh/f Aral | 4.13 | 4.02 | 4.18 | 4.64 | 5.19 | 4.9 | | | | | | |
| 2 | sh/f Muynak | 6.69 | 7.01 | 7.48 | 8.54 | 7.02 | 7.21 | | | | | | |
| 3 | sh/f Kazakhdarya | 7.27 | 7.3 | 7.61 | 8.36 | 7.76 | 6.52 | | | | | | |
| 4 | sh/f Raushan | 4,21 | 4,4 | 4,6 | 3,03 | 5,36 | - | | | | | | |

Dynamics of groundwater level in the Amudarya delta and Prearalie, 2009-2011

months, 2009-2011

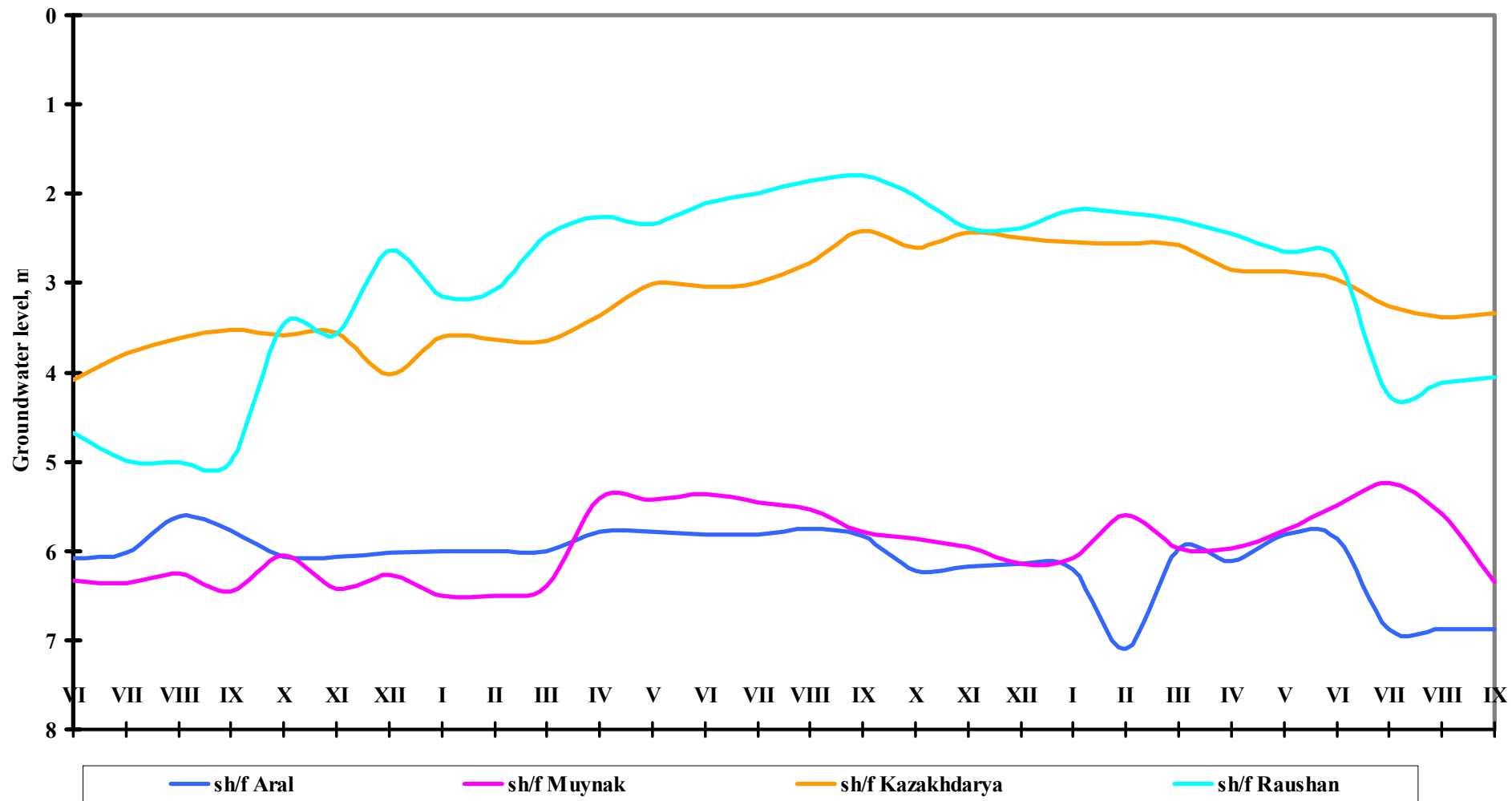


Fig.5

Changes in groundwater salinity in the Amudarya delta and Prearalie over 2009-2011

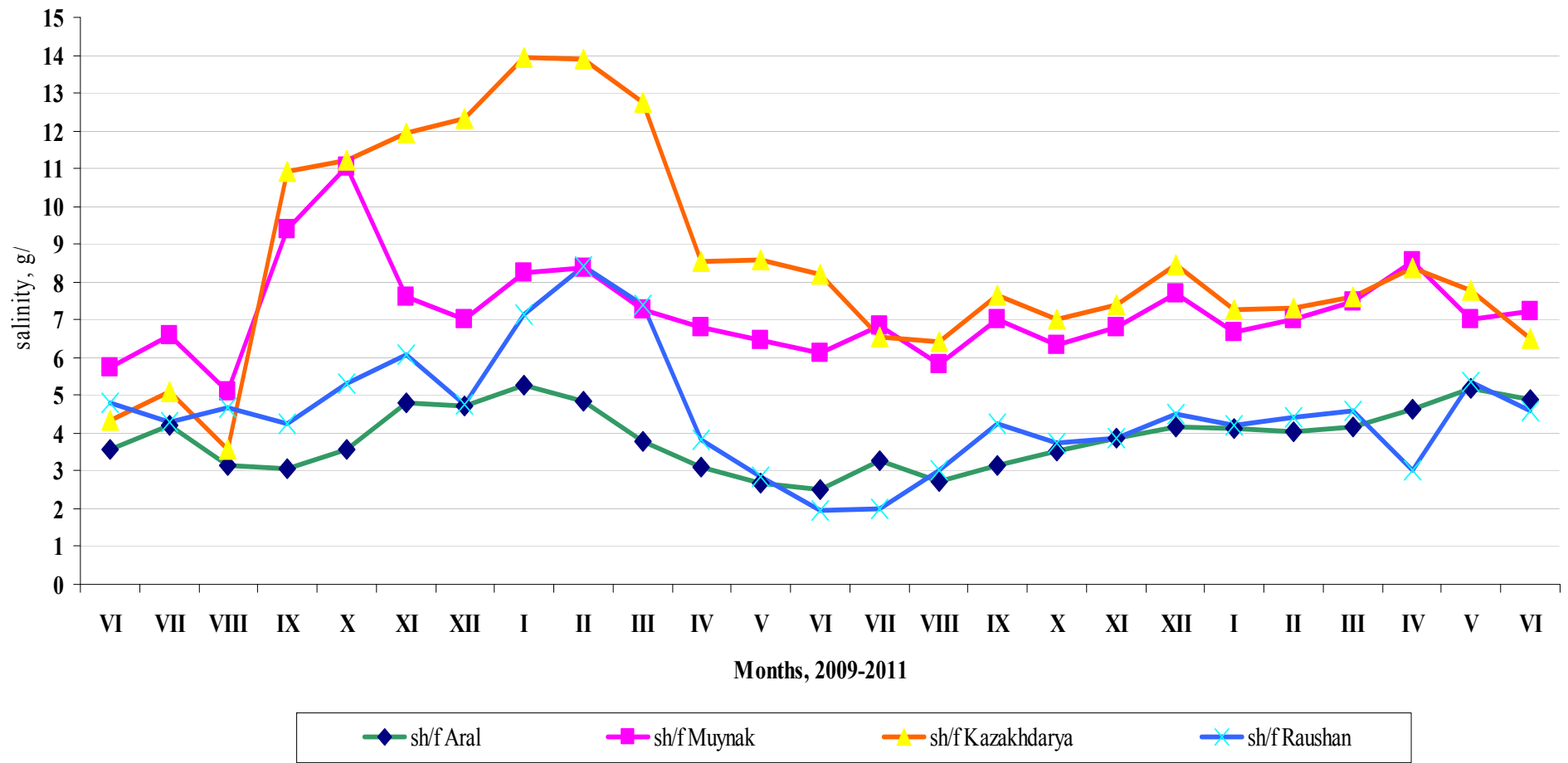
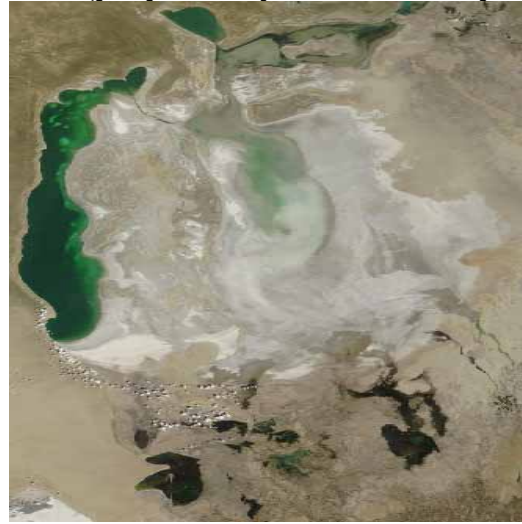


Fig. 6

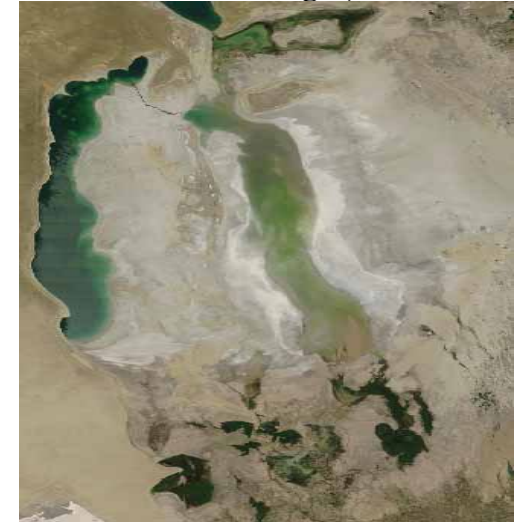
Transformation dynamics of the Aral Sea (prepared by SIC's GIS experts on the basis of satellite images).



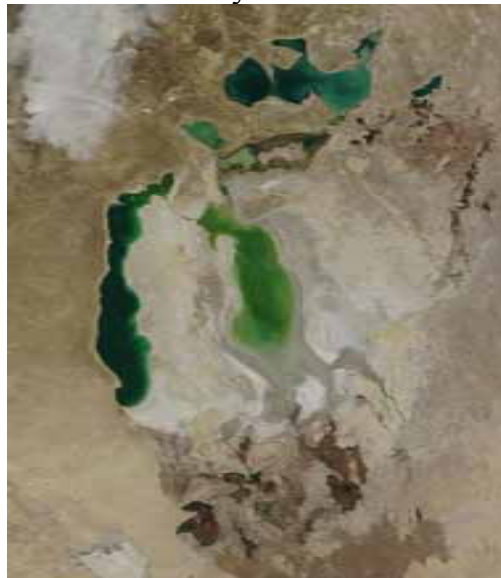
May 2009



April 2010



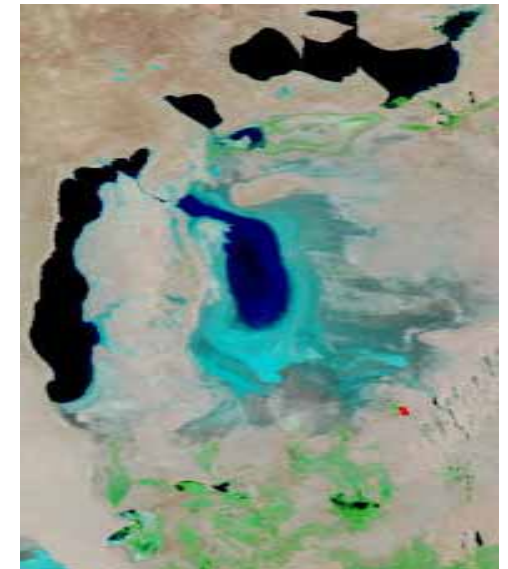
June 2010



November 2010



March 2011



August 2011

Fig.7

